# Outbreak of *Mytilopsis sallei* (Récluz, 1849) (Bivalvia: Dreissenidae) in Australia

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## Chronology

Darwin is the largest port on the tropical northern Australian coast. On 27th March 1999, during the wet season phase of the Port of Darwin Survey for adventive marine species, divers discovered dense (23,650 individuals $m^{-2}$) aggregations of a thin shelled "mussel" on floating pontoons, concrete piles, retaining walls, ship's hulls and mooring ropes (Fig. 1) inside Cullen Bay Marina, the largest of three marinas within Darwin Harbour. Early the following morning RCW observed specimens attached to the hull of a motor yacht that was in the lock leaving the Marina. Because of the great extent of tidal rise and fall around Darwin (approx. 8 metres on springs), all three marinas have systems of lock gates separating the waters of the marina from the sea.

RCW identified the "mussels" on 29th March as *Congeria (Mytilopsis) sallei* (Récluz, 1849) based on their exact conchological and anatomical agreement with descriptions in the recent literature (Morton, 1981, 1989; Marelli & Gray, 1983). The reasons behind the choice of this particular scientific name are given in the section on nomenclature below. The identification was verified the following day by Shirley Slack-Smith on the basis of preserved specimens. This represents the first record of a species from the family Dreissenidae and superfamily Dreissenoidea for Australia (Prezant, 1998).

The extent of the Darwin outbreak was revealed during intensive searches by rapid response teams over the next week. One team discovered a population of small individuals (6 individuals $m^{-2}$) in the second marina (Tipperary Waters Marina) and a lightly fouled vessel in the third marina (Frances Bay Marina). Other teams discovered three moderately to heavily fouled vessels moored at different locations outside the marinas, but still within Darwin Harbour. Checking revealed that these five secondary infestations could all be confidently traced back to Cullen Bay Marina. Extensive searches failed to discover any individuals elsewhere in Darwin Harbour itself. As the previous dry season phase of the Port of Darwin Survey in August 1998 had also failed to reveal a single *M. sallei*, live or dead, anywhere within Darwin Harbour, we concluded the outbreak in Cullen Bay Marina must have taken place during the previous six months.


**Figure 1.**
Section of 10 mm diameter polypropylene rope from Cullen Bay Marina heavily fouled with *Mytilopsis sallei*.

The presence of *Mytilopsis sallei* in Darwin posed a threat to the pearl farming and aquaculture industries in addition to both commercial and recreational fisheries throughout tropical and warm temperate Australia because of its propensity to cause severe fouling on marine structures (Ramachandra et al, 1975; Morton, 1981, 1989). *M. sallei* is an opportunist with very fast growth, early maturity, high fecundity and wide tolerance to salinity, oxygen and pollution levels (Ramachandra et al, 1975; Morton, 1981). In a commendable response to the threat, the Northern Territory Government declared a state of Natural Disaster on 1st April, closed and quarantined all three marinas, and instigated an eradication campaign. Under this campaign Cullen Bay Marina and its lock was treated with a total of 163,040 kg liquid sodium hypochlorite (i.e., a volume yielding a final concentration of 12% chlorine in solution) plus 4,325 kg powdered copper sulphate (i.e., a volume yielding a maximum final, 0.45 µm filtered, concentration of 0.5 mg litre$^{-1}$ copper in solution) between 3rd and 22nd April (S. Sly pers. comm., 25 May 1999 and D. Parry pers. comm., 8 June 1999). Tipperary Waters Marina and Frances Bay Marina and their locks were treated similarly (1,980 kg sodium hypochlorite plus 1,050 kg copper sulphate, and 21,980 kg chlorine plus 2,075 kg copper sulphate respectively) (S. Sly pers. comm., 25 May 1999). The maximum final, 0.45 µm filtered, concentration of copper in solution reached 0.8 mg litre$^{-1}$ in both Tipperary Waters Marina and Frances Bay Marina (D. Parry pers. comm., 8 June 1999). Fouled vessels outside the marinas were recalled into the nearest marina prior to treatment, or lifted from the water, or, in the case of the bamboo raft *Nale Tasih* that had drifted/sailed from Kupang and become heavily fouled in Cullen Bay whilst on display there between 8th January and 28th March, burnt above high water mark.

The chemical treatments of all three marinas were effective in killing *Mytilopsis sallei*. The last known living individual of *M. sallei* was detected in Cullen Bay Marina on 18th April. There was also considerable, but not complete, mortality of other marine life (RCW pers. obs.). As of 31st May, levels of copper remained high but the toxicity to marine life had decreased due to formation of non-toxic, organic copper compounds (D. Parry pers. comm., 8 June 1999). As of this same date, regular post-eradication surveys had found no live *M. sallei* inside any marina and no settlement had been detected in Darwin Harbour. Ongoing surveys for *M. sallei* will monitor the re-establishment of the (largely adventive) fouling community dominated by the barnacle *Balanus amphitrite* Darwin, 1854 and the serpulid tubeworm *Ficopomatus uschakovi* (Pillai, 1960) within the marinas, and check for settlement of *M. sallei* in the Harbour itself.

The possibility of residual populations of *Mytilopsis sallei* remains of great concern. In addition, the risk of reinvasion by *M. sallei* or the introduction of other marine organisms continues (Carlton & Geiler, 1993). Under the protocols put in place since the outbreak, masters of suspect incoming international vessels are requested to undergo an inspection of their vessel's hull (by divers) plus treatment of seawater intake systems and such inspections are strongly recommended for all such vessels intending to enter one of the marinas. No incoming (recreational or commercial) vessel is subject to mandatory inspection. Neither are protocols in place to survey the ballast water tanks of vessels, but an

Australia-wide Code of Practice for commercial shipping recommends against discharge of ballast in ports and it is illegal to discharge ballast water inside the Darwin marinas. This outbreak should reinforce the need for thorough quarantine inspections of hulls and ballast tanks of all vessels arriving at ports in the minds of legislators (Willan, 1987).

Details of the pre-eradication surveys, the eradication program and post-eradication monitoring will be reported elsewhere.

**Nomenclature**

The difficulties experienced in selecting a scientific name for this invading bivalve have reflected underlying taxonomic uncertainties at both generic and specific levels. Considering: (i) diversity in the present day, global, dreissenid fauna is small (i.e., there are only six - probably fewer - obligate marine and brackish water species (Marelli & Gray, 1983), plus one - possibly more - obligate freshwater species (Morton et al, 1998)), (ii) some dreissenids, most notoriously the freshwater *Dreissena polymorpha* (Pallas, 1771) (Nalepa & Schloesser, 1993), can be serious pests and occur in enormous densities in readily accessible habitats, and (iii) nomenclatural stability is essential for legislators, we are very surprised that the only comparative taxonomic study anywhere in the world reviews just two species in the northwestern Atlantic Ocean (Marelli & Gray, 1983).

The third requirement listed above has dictated our choice of the name *Mytilopsis sallei* in this note because of its exclusive usage in the marine pest literature. But that name may not necessarily be nomenclaturally correct. Schütt (1992) has emphasised the homology of shell structures in the umbonal region between *Mytilopsis* Conrad, 1858 and the chronologically older genus *Congeria* Partsch, 1835, in that the anterior byssal retractor muscle is attached to an apophysis postero-dorsal to the septum in both genera. Therefore Schütt has concluded the names should be synonymous, with *Congeria* being used for all the (fossil and living) species or, at the very least, with *Mytilopsis* being accorded subgeneric status under *Congeria*. In a recent paper on the extant, subterranean, cave-dwelling *Congeria kusceri* Bole, 1962, Morton et al. (1998) have continued to advocate the separation of *Mytilopsis* from *Congeria* as genera, but they have not segregated those characters that are adaptations to the unique habitat from potential generic apomorphies; it is unlikely that Morton would consider that all fossil *Congeria* species had been subterranean or cavernicolous. Cladistics-based phylogenetic research presents a more objective technique to solve the disagreement over the generic name.

Uncertainty will also surround the "correct" specific name until further research is undertaken. Although the name *sallei* Récluz, 1849 is in general usage relating to western Atlantic (Marelli & Gray, 1983) and Indo-Pacific (Marelli & Gray, 1983; Morton, 1989) Ocean populations of this bivalve, their conspecificity has only once been confirmed (Marelli & Gray, 1983), and that on shell characters alone. Anatomical and genetic studies are now urgently needed to test this hypothesis and, simultaneously, to evaluate the five other nominal species. For instance, if *africana* van Beneden, 1835 is also conspecific, as has been speculated (Nuttall, 1990), that name should automatically take precedence over

*sallei*. [But that synonymy would cause such enormous instability we would not hesitate to present a case to the International Commission on Zoological Nomenclature to invoke its plenary powers to suppress *africana*.] Only when this research is published will it be possible to speculate on where the founders of the Darwin population originated because there is now no possibility of identifying the offending vessel.

**Acknowledgements**

Were it not for the mammoth concerted effort at eradication by scientists, government, industry and the public, *Mytilopsis sallei* had the potential to become established in ports throughout (tropical and warm temperate) Australia. Shirley Slack-Smith (Western Australian Museum) is thanked for confirming the identification of *M. sallei* and for commenting on the draft for this note. We also thank the following senior managers for their corrections to the draft: Rex Pyne (Deputy Director of Fisheries, Northern Territory Department of Primary Industry and Fisheries), Andria Marshall (Project Leader, Northern Territory Aquatic Pests Program), Patrick Filmer-Sankey (Director, MAGNT) and Ron Thresher (Head, CRIMP). We are grateful to Steve Sly (Northern Territory Aquatic Pests Program) for providing the statistics on the quantities of chemicals used to treat the Darwin marinas, David Parry (Northern Territory University) for their final concentrations, and Charlotte Watson-Russell (MAGNT) for the name of the tubeworm.

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**Note added in proof**

Two further incidents have highlighted Australia's vulnerability to reinvasion by *Mytilopsis sallei*. On 5th September 2000, divers undertaking monitoring surveys for *M. sallei* discovered a moderate infestation of this bivalve on the keel and hull of a vessel moored at the quarantine buoy in Darwin Harbour. The vessel, a 22 metre long, wooden, Indonesian fishing boat, had been intercepted by the Australian Navy thirteen days previously fishing in Australian territorial waters and escorted to Darwin. The skipper admitted the offence and was fined, and the vessel was ordered to leave Australian waters for its home port in Probalinggo, northeastern Java, which it did on 6thSeptember. A second, similar vessel from the same part of Indonesia, that had been escorted to the same site in Darwin Harbour on 8th September for the same alleged offence, was found to be heavily infested with *M. sallei*. It was ordered to leave Australian waters that same day without any prosecution being effected.